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tions for collecting scale insects was published as Part L. of Bulletin 39, and a circular was issued relating to the collection and preservation of the bones and teeth of the Mastodon and Mammoth.

Bureau of Ethnology reports.—The seventeenth report of the Bureau of Ethnology, for the year ending June 30, 1896, was sent to the Public Printer on July 6, 1897, and proof reading was completed before June 30, 1898, but actual presswork has not begun. The eighteenth report is also in the printers' hands, but no progress has been made beyond the revision of some first proofs.

Astrophysical Observatory publications.—There has been prepared and is now ready for publication a full report on the results of the researches carried on in the Astrophysical Observatory since its establishment and this work will probably be printed in quarto form during the next fiscal year, the cost of the publication being charged to the appropriation for the Observatory under authority of Congress.

LIBRARY.

The number of accessions to the library has been greater than at any time heretofore, the total entries of volumes, parts of volumes, pamphlets and charts reaching 40,715, an increase of nearly 5,000 over the previous year. The greater part of this has been sent to the Library of Congress to be placed with the Smithsonian deposit.

The Museum library shows a greatly increased use over last year. The limited quarters assigned for library purposes in the Museum are so greatly crowded that it has become necessary to provide additional book room, for which purpose a gallery directly adjoining the library has been erected and fitted with shelves, where space is provided for 18,000 volumes. This is rendered necessary by the purchase for the Museum, by Congressional appro-

priation, of the scientific library of the late Dr. G. Brown Goode. The Institution is especially fortunate in being able to obtain this library and the Museum now has the benefit of possessing the collections of books both of Professor Baird and Dr. Goode.

THE AGRICULTURAL EXPERIMENT STATIONS.*

THIS is the fourth annual report on the work and expenditures of the agricultural experiment stations in the United States, made by the Director of the Office of Experiment Stations, under instructions from the Secretary of Agriculture. As heretofore, the report is based on three sources of information, viz, the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, in accordance with the Act of Congress; the printed reports and bulletins of the stations, and the reports of personal examinations of the work and expenditures of the stations made during the past year by the Director, Assistant Director and one other expert officer of the Office of Experiment Stations. The stations in all the States and Territories were visited since the previous report was transmitted to Congress.

During the past year the stations have, as a rule, steadily pursued their investigations. There have been a smaller number of changes in the workers; the general management has been less subject to radical and unwise changes; much useful work has been accomplished, and the facilities for investigations have been increased.

RELATIONS OF COLLEGES AND STATIONS.

There has been much activity during the past year in the developing and strengthening of courses of instruction in agricul-

* From Report to Congress on Work and Expenditures of Agricultural Experiment Stations for 1898.

ture in the land-grant colleges with which the stations are connected. This has been to the advantage of the stations in a number of ways. The buildings and equipment of the colleges have been materially increased, and this has given the stations better facilities for their work. The instruction in agriculture has been specialized, which has necessitated the employment of a larger number of well-trained officers, many of whom have devoted a portion of their time to station work. The governing boards and general officers of the colleges are coming to see more clearly the real significance and importance of experiment station work. They have, therefore, been more willing to make proper arrangements for the efficient conduct of this work and to pursue a more liberal policy toward the stations. In a number of instances there has been a more definite separation of the operations on the farms and in the barns, creameries, laboratories, etc., so that a definite place has been made for original investigations in agriculture, and these have been clearly differentiated from the work and facilities connected with instruction. It is coming also to be more clearly seen that care must be taken lest the routine duties connected with instruction shall so exhaust the energies of the officer employed in both college and station that he will not be able to devote his best energies to the more difficult task of originating and conducting successful investigations in agricultural science. The outlook is, therefore, more hopeful for the building up, in connection with these institutions, of strong departments of original investigation on behalf of agriculture, which shall not only accomplish great good by the practical results of the investigations disseminated among the farmers, but shall also materially aid in the proper development of courses of instruction in agriculture in the land-grant institutions.

THE ORIGINAL INVESTIGATIONS OF THE STATIONS.

The year past has shown considerable progress in the importance and thoroughness of the original investigations pursued at our stations. The number of officers competent to undertake such investigations has been increased. There has been greater specialization of the work assigned to these officers. There have also been encouraging indications that cooperation between the officers engaged in different lines of investigation is being more efficiently secured. More attention is being given to the consideration of problems which affect in a general way important agricultural interests in the several States or are of fundamental importance in different branches of agriculture wherever pursued. It is becoming more clear that it is much better for an individual station to undertake thorough original investigations in a few lines and hold steadily to these until definite results are secured than to scatter the work among a variety of small operations. If a station can make itself preeminent for original work in even one or two lines it gains strength in its own State and elsewhere which it could get in no other way; and now, that general information regarding the work of all the stations is more widely disseminated, there is less reason why any one station should attempt very many lines of work. The success of those stations which have devoted themselves most largely to original investigations has, without doubt, been a powerful factor in stimulating the general adoption of such a policy. The wisdom of the framers of the Hatch Act in limiting the work of the stations organized under that act to original and scientific investigations which shall either attack agricultural problems in a new way or have reference to the application of ascertained facts or principles to particular or local phases of these problems is more and more

apparent. Every dollar of the fund thus given from the National Treasury is needed for thorough original investigations on behalf of the vast and varied interests of agriculture in this country and the dissemination of the results of such investigations. The more strictly this fund is applied to these purposes the more rapid development will our agriculture have along the lines of permanent success.

DEMONSTRATION EXPERIMENTS.

As the work of the stations develops it is seen that more adequate provision should be made for the application of the results obtained by the stations in actual practice in different localities, in order that the best methods of local application of these results may be worked out, and that the farmers may be taught how to make the best use of the work of the stations. It is in this direction that there is the greatest need for a generous policy on the part of the States toward the stations. By supplementing the Hatch fund for work of this kind the States in a number of cases have greatly hastened the direct application of the results of original investigations to actual farm practice, and have done much toward arousing the farmers to a keener sense of the practical value of station work. With the aid of funds furnished by the States and by this Department thousands of the more simple experiments in the growing of different crops, such as sugar beets, and the use of fertilizers, have been made by farmers in different parts of the country. It is much to be hoped that the States will more fully take up this work, and that it will be more thoroughly organized, as is being done, for example, in the State of New York, where special appropriations have been made for experiments of this character under the direction of the stations. A great deal of the work of the testing of varieties of agricultural and horticultural plants, to be of any

practical value, needs to be carried on in a number of different localities in each State, and this can probably be most economically and efficiently done with the cooperation of intelligent practical farmers and horticulturists. While cooperative experiments may often be of value in connection with original investigations, they will most often be of use in determining the extent to which the results of such investigations may be applied in actual practice.

DISSEMINATION OF INFORMATION.

The Hatch Act expressly provides that a portion of the funds granted the stations by the United States shall be expended for printing and distributing reports and bulletins, but limits the scope of the information to be thus published to the 'results' of their investigations. The act further grants the stations the franking privilege for the distribution of their publications. Circumstances have compelled the stations to go far beyond the limit set by the Act of Congress as regards the character of the information which they have disseminated. A number of causes have contributed to make a very heavy demand upon the stations for information regarding every detail of farm theory and practice. The successful issue of many of the investigations of the stations has been a very important factor in creating this demand. There has also been the necessity of giving the farmers preliminary information along the line of many investigations, in order that they might clearly understand the practical application of the new results which the stations had obtained. But beyond this there has been during the last decade a remarkable awakening of our farmers to the desirability of having more definite information regarding all matters connected with their business. The result has been that the stations and this Department have been led to publish a vast amount of information, both old and

new, which has been freely distributed to farmers in every county of the Union. Nothing like it has ever been seen before. No country has ever before attempted so systematic and thorough a distribution of information to its agricultural population, and no masses of farmers have ever so eagerly sought for information as have our own within the past few years; and not only has the free information furnished by the stations and the Department been eagerly sought for, but this period has also been remarkable for the amount of accurate information distributed to the farmers through the agricultural press and other newspapers and the number of good books on farming which have been published. Besides this, the agricultural societies, granges, farmers' institutes, and other associations have been more active than ever before in discussing the problems of agriculture and in securing the services of experts and successful practical men to lay before them the fruits of science and experience for the more successful conduct of the art of agriculture. Such an intellectual awakening must have most important results, and there is every indication that it will go on increasing in volume and force until it has thoroughly permeated the entire agricultural population of the country.

To secure the best results such a movement needs the wisest leadership to guide its aspirations in the best directions. Fortunately the facilities for agricultural education of a high order have been greatly increased within a few years, and there is to day a much larger number of well-trained men who are competent to give the farmers the information which they demand than was the case ten years ago. What is especially needed now is the more thorough organization of the agencies for the diffusion of information among the farmers. Thus far the officers of our agricultural colleges and experiment stations have had to

bear the heaviest portion of this burden, and it is much to be wondered at that they have so well discharged the great variety of duties imposed upon them; but the time has come when there must be a specialization of work in this as in other directions if we are to have the most efficient agencies for the securing as well as for the disseminating of agricultural information.

Everybody now admits that much may be done to advance agriculture by scientific investigations, but the absorbing character of this work, if it is to be well done, is not as yet thoroughly appreciated. The discovery of new truth is the chief function of our experiment stations, but the amount of new truth which they will discover will be very largely determined by the extent to which the investigators are left to pursue their investigations without interruption. The same is true regarding the teacher in our agricultural colleges. He must have time to keep pace with the increasing volume of new information which is being published, and be able to give his best energies to the planning of courses of study, and come before his pupils with an active mind, in order that he may not only impart knowledge to them, but may inspire them with something of his own enthusiasm regarding the subjects which he teaches. The writer of popular bulletins and books for farmers must not only have ample knowledge, but he must have had time to acquire the most complete sympathy with his readers and a style of composition which is confessedly the most difficult to attain. The farmers' institute worker should not only have wide familiarity with the science and practice of agriculture, but he should also have a ready wit and the fine art of putting things in a clear light and changing his point of view according to his audience, which can only come through natural aptitude combined with much experience in public speaking. Many of our

best investigators and teachers have a wonderful versatility, so that they succeed pretty well in a number of different lines of work, but after all there is some one direction in which they excel, and one or the other feature of their work is almost sure to suffer if they attempt a great variety of performances. We must in the future leave the investigators more fully to their investigating, the teachers to their teaching, the writers of agricultural publications to their writing, and the farmers' institute workers to their speaking.

Already the movement in this direction has begun. In our colleges changes are being made by which the experiment station offices are given more time for their investigations, and additional teachers are being employed. One of our stations has recently employed an officer whose chief business it is to edit the station publications and prepare popular bulletins for the farmers. At another institution the superintendent of farmers' institutes is a separate officer, and in a few States a corps of institute workers, exclusive of the college and station officers, has been organized. This movement should be encouraged, and the governing boards should see to it that the officers of stations are protected against unreasonable demands on their time, which would take them away from the planning and conducting of thorough original investigations.

We do not urge this because we wish to limit the dissemination of compiled information to our farmers. We fully recognize the importance of this, and we would have the States and the National Government make ample provision for compiling and publishing all the information which our farmers ought to have. But we would insist more strongly than ever that original investigations by our experiment stations should be made more thorough and increased in number, in order that the stream

of new information may increase in purity and volume with every year.

LIBERALITY OF THE STATES.

One of the most encouraging things connected with the progress of our experiment stations has been the disposition of the State Legislatures to deal more liberally with them as the importance of their work has become more apparent. This liberality has manifested itself in a number of ways. There have been large grants of money directly for experiment-station purposes. In the erection of buildings for the colleges provision has often been made for increasing the facilities for experiment-station work. The printing of station publications is regularly done in a number of States at the public expense. The laws relating to inspection of agricultural commodities have been so framed that a considerable revenue has accrued to the stations for purposes of investigation. The increased means thus acquired have enabled the stations in a number of States to push their work far beyond what could have been accomplished with the Hatch fund alone. In comparing the work of different stations this factor should always be taken into account, and communities in which a more narrow policy has been pursued must not expect that their stations will be able to do as much for their agriculture as is accomplished by stations receiving more liberal treatment.

We believe that under our American system nothing can be more promotive of the highest interests of the stations than that the States should take a just pride in strengthening and developing their operations, and thus prove to the world that scientific institutions based upon the support of the people can be made as strong and efficient as those which are directly maintained under the centralized authority of the General Government.

POLITICAL INTERFERENCE AND THE INJURY
TO SOME STATIONS THEREBY.

While as a rule our stations have been free from the baneful influence of the introduction of political considerations into their management, there are still some States and Territories in which politics have been a disturbing element in the affairs of the stations during the past year. This has resulted in unreasonable changes in the membership of the governing boards, the removal of efficient officers without cause or on inconsequential pretexts, and, in a few cases, in the appointment of notoriously incompetent men as station officers. This Department has consistently held that where such an unsettled state of affairs exists the real objects of the Hatch Act can not be attained, since these involve, first of all, a corps of competent specialists working under a well-defined policy, outlined to cover a series of years of interrupted investigation, and having an assurance that their work will be judged on its merits. It was not hesitated to protest against the action of governing boards wherever there was a plain case of violation of the proper principles of station management. The communities which permit such things, of course, reap their reward in the weakness or inefficiency of the operations of the stations. The remedy lies very largely with the people, and every effort should be made to form intelligent public sentiment on this subject.

AGRICULTURAL INVESTIGATIONS IN ALASKA.

For the past two years Congress has included in the appropriation for agricultural experiment stations an item for investigations regarding the agricultural capabilities of Alaska, with the special object of determining the desirability and feasibility of establishing agricultural experiment stations in that Territory. With the first year's appropriation a preliminary agricultural and botanical survey of Alaska was made, a

report on which was transmitted to Congress. The results of this reconnoissance were so encouraging that the appropriation for this work was doubled, and during the present year not only has the survey been continued, but reservations of land have been made at Sitka, Kadiak and Kenai in Cook Inlet, and some successful experiments in growing and maturing barley, oats, flax, potatoes and other vegetables have been made, and excellent clover and grasses have been grown under cultivation. The detailed report of this work will soon be transmitted to Congress, and it is hoped that hereafter Alaska will receive at least the same financial support for experiments in agriculture as is given to the other portions of the United States by the National Government.

EXPERIMENT STATION IN HAWAII.

The Hawaiian Islands having been annexed to the United States, the question of the development of their agriculture through experimental inquiries, conducted on the same plan as in other parts of the United States, has become an important one. It seems proper, therefore, in this connection to call attention to the fact that an experiment station has been in successful operation at Honolulu since 1895. This station is under the direction of the Hawaiian Sugar Planters' Association, which supplies the funds for its maintenance. The Director and Chief Chemist is Dr. Walter Maxwell, formerly an assistant in the Division of Chemistry in this Department, and later one of the chemists of the Louisiana Experiment Stations. The other members of the staff are two chemists and a field assistant. This station has studied especially the problems relating to the culture of sugar cane and the manufacture of cane sugar, but there have also been experiments with fertilizers, and a comprehensive investigation of the soils of the Islands. The results

of the station's work have been published in the *Hawaiian Planters' Monthly*, and in bulletin form. The station has been ably directed, and its work has been systematically and successfully pursued.

THE OFFICE OF EXPERIMENT STATIONS.

Besides the work done in the supervision of expenditures of the stations and in conferences and correspondence with station officers, this office has continued to collect and disseminate information regarding the progress of agricultural investigations throughout the world. Not only has this feature of its work been made more thorough, as regards the review of the literature of agricultural science for the benefit of our station workers, but the preparation of popular *résûmés* of station work has been more systematically pursued. A series of such publications, denominated Experiment-Station Work, has been begun in connection with the Farmers' Bulletins issued by the Department.

During the year the office issued about 43 documents, aggregating 2,920 pages. These include 13 numbers of the Experiment Station Record, with detailed index, 12 bulletins, 7 Farmers' Bulletins (including 4 numbers of the subseries entitled 'Experiment Station Work'), 1 circular, 4 articles for the Year Book of the Department, the annual report of the Director, a report to Congress on the work and expenditures of the experiment stations, and 4 special articles published as separates.

The ninth volume of the Experiment Station Record comprises 1,214 pages, and contains abstracts of 317 bulletins and 56 annual reports of 53 experiment stations in the United States, 201 publications of the Department of Agriculture, and 842 reports of foreign investigations. The total number of pages in these publications is 56,569. The total number of articles abstracted is 1,810, classified as follows: Chemistry,

121; botany, 86; fermentation and bacteriology, 28; zoology, 31; meteorology, 57; water and soils, 72; fertilizers, 85; field crops, 153; horticulture, 138; forestry, 16; seeds and weeds, 41; diseases of plants, 107; entomology, 252; foods and animal production, 186; dairy farming and dairying, 151; veterinary science, 134; technology, 11; agricultural engineering, 38; statistics, 103. Classified lists of articles, in some cases with brief abstracts, are also given in each number. The aggregate number of titles thus reported is 2,471.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation, under the Act of Congress of March 2, 1887, in all the States and Territories. As stated above, agricultural experiments have been begun in Alaska with the aid of national funds, and an experiment station is in operation in Hawaii under private auspices. In each of the States of Alabama, Connecticut, New Jersey and New York a separate station is maintained, wholly or in part, by State funds, and in Louisiana a station for sugar experiments is maintained, partly by funds contributed by sugar planters. Excluding the branch stations established in several States, the total number of stations in the United States is 54. Of these, 52 receive the appropriation provided for in the Act of Congress above mentioned. The total income of the stations during 1898 was \$1,210,921.17, of which \$720,000.00 was received from the National Government; the remainder, \$490,921.17, coming from the following sources: State governments, \$341,897.94; individuals and communities, \$177.20; fees for analyses of fertilizers, \$93,677.00; sales of farm products, \$65,358.25; miscellaneous, \$20,312.48. In addition to this the Office of Experiment Stations had an appropriation of \$35,000 for the past fiscal year, including \$5,000 for

the Alaskan investigation. The value of additions to equipment of the stations in 1898 is estimated as follows: Buildings, \$109,851.65; libraries, \$11,700.73; apparatus, \$19,195.43; farm implements, \$10,800.27; live stock, \$13,151.33; miscellaneous, \$11,972.97; total, \$176,469.41.

The stations employ 669 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 75; chemists, 148; agriculturists, 71; experts in animal husbandry, 10; horticulturists, 77; farm foremen, 29; dairymen, 21; botanists, 50; entomologists, 46; veterinarians, 26; meteorologists, 20; biologists, 11; physicists, 11; geologists, 6; mycologists and bacteriologists, 19; irrigation engineers, 7; in charge of substations, 15; secretaries and treasurers, 23; librarians, 10, and clerks, 46. There are also 21 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds and buildings, apiarists, herdsman, etc. Three hundred and five station officers do more or less teaching in the colleges with which the stations are connected.

During 1898 the stations published 406 annual reports and bulletins. Besides regular reports and bulletins, a number of the stations issued press bulletins, which were widely reproduced in the agricultural and county papers. The mailing lists of the stations now aggregate half a million names. Correspondence with farmers steadily increases, and calls upon station officers for public addresses at institutes and other meetings of farmers are more numerous each year. The station officers continue to contribute many articles on special topics to agricultural and scientific journals. A number of books on agricultural subjects, written by station officers, have been published during the past year.

A. C. TRUE.

U. S. DEPARTMENT OF AGRICULTURE.

PHYSIOLOGICAL OSMOSIS.

IN going over this subject I have discovered a very simple method, which I would offer as an improvement on that of van't Hoff, referred to, and its results given by Starling in Schaefer's 'Physiology.'

All methods as to osmotic pressure are an application of the discovery that it is the largeness or smallness of the chemical molecules of solutes (matters in solution) that determines whether they shall be estopped by or shall pass through membranes. Citing common-places of chemistry, we know that a gram-molecule of hydrogen gas, with a numerical value of 2, has the same volume as a gram-molecule of oxygen, weighing 32 per molecule, and as a gram-molecule of cane sugar dissolved in water, having a molecular weight of 342 and when in solution acting like a gas. The common volume of a gram-molecule of each of these substances, at 0°C. and ordinary barometric pressure, is 22.32 liters; if the gases be compressed to the volume of 1 liter they will exercise a pressure of 22.32 atmospheres per gram-molecule. This is the result with all solutions in water when taken according to their molecular pressure. But it will not apply to electrolytes, as these are broken up by the water; thus for sodium chlorid the value is 1.6 times this amount.

Taking as an example a 1 per cent. solution of cane-sugar in water, a gram-molecule, that is 342 grams, of the sugar are dissolved in 34,200 grams of water, or $\frac{1}{342}$ of a gram-molecule in a liter of water. This will, therefore, exert $\frac{1}{342}$ of 22.32 atmospheres of pressure; or taking 10.33 meters of water pressure for an atmosphere, we find from the osmotic pressure of the solution at 0°C. $p = \frac{1}{342} \times 22.32 \times 10.33 = 6.748$ meters of water-pressure.

At the ordinary temperature of the body, 37°C., this will be increased by $\frac{37}{273}$ of